FORCEnet
engineering conference
JUNE 28 - 30, 2005 NORFOLK CONVENTION CENTER

Assessing the War Fighter as Part of the System

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SPAWAR 052
30 June 2005

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FORCEnet Chief Engineer

General Human Tasks

Traditional Focus

Humans Operate Equipment

FORCEnet Focus (Tactical Decisions)

Humans allocate, deploy, and position resources

Humans collect, organize, and transfer information

Humans make decisions

QA Focus

Humans monitor and modify processes

Humans produce, detect, and correct errors

Traditional HSI Issues

Roles and tasking (What are we trying to do?)

Tool: Process & task analysis

Performance measurement (How well do we do it?)

Tools: Reliability and Completeness Assessments

Timing and Latency Assessments

Error Analysis

Performance shaping (How can performance be improved?)

Tools: Training, performance aids

Performance Shaping Factors

Personnel Changes

- Capabilities
- Training & Experience
- Fitness

Situation Awareness Support

- Event flags
- Process Status Displays: Relate events to tasking and goals
- Projections to future states

Work environment modifications

- Decision and performance aids
- Workload tuning
- Process modifications

The HSI ISSUES

How to represent human performance in NCDP models

How to isolate the effects of equipment and human performance on outcomes

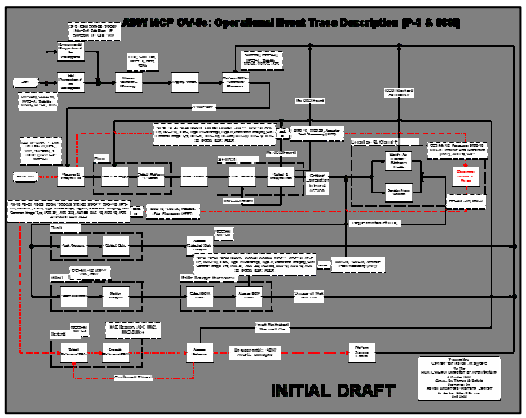
When to suggest HSI interventions

Link and Node Approach

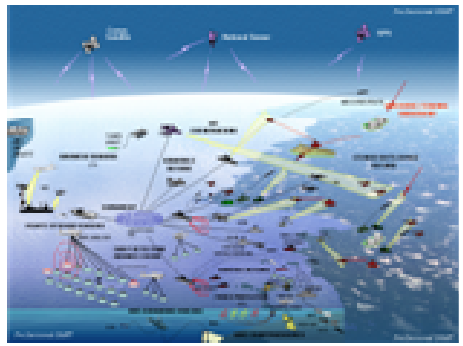
1. Use NCDP use case diagrams to identify process decision nodes and communications links.
2. Express both equipment and human performance in terms of reliability, latencies, and error opportunities.
3. Calculate those expressions for each link and node in the process.

NCDP Assessment Process

Operational Activity Sequence shows mission requirements overlaid with systems whose functions support the activities.



TACSIT provides the setting in which mission activities are performed



TACSIT

Use Case: Time 2012. Open Ocean. Fixed acoustic surveillance indicates transit of sub into the area of operations near ESG. P-3 (AIP) detects threat on radar (ARPDD) during patrol of outer zone and confirms threat visually using FLIR. P-3 conducts Mk 54 LWT Attack, BDA Inconclusive (Some debris). P-3 initiates IEER Search and detects a 2nd Threat near a NOTACK zone. P-3 requests Submarine to assist prosecution from SCC. Surface Units Calls Up SSN. SSN comes to PD.
Tactical information regarding threat is passed via CUP and SATCOM communication channel. SSN vectored to intercept projected target track. Threat detected in high speed transit and a solution is developed. Target slows down at approx. 1.5x effective firing range and contact lost. Presets developed for Mk 48 Mod 7 Torpedo and continuously updated. Target re-acquired at 0.5x effective firing range. SSN maneuvers to develop firing position. SSN launches ASW Torpedo. BDA Conclusive (UW Detonation & Implosion Noises).

Use Cases/Threads define the family of systems (FoS) used to carry out an element of a mission and the information flows between systems

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

Use Cases/Threads

Decision Node Representation

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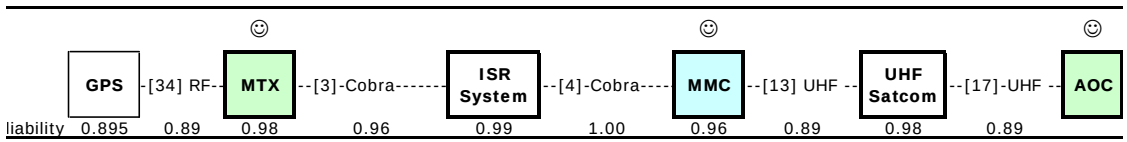
are needed to see this picture.

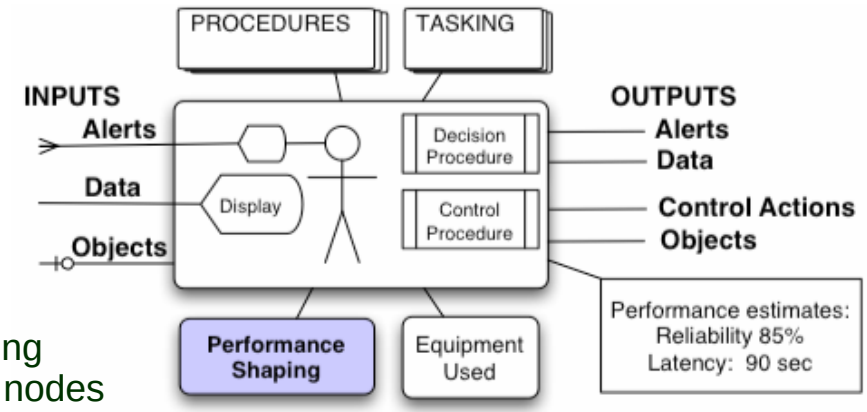
Link and Node Analysis -
Identifies decision nodes and communication links



Decision Node Structure

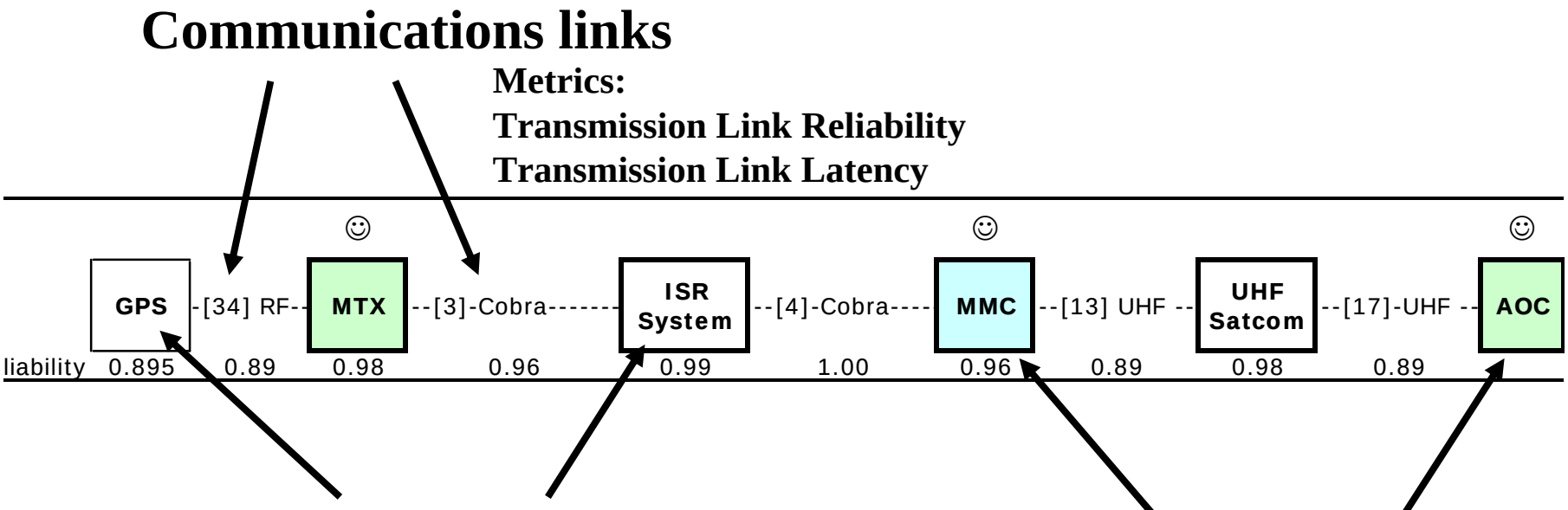
Distribution of information to decision nodes

Performance shaping within the decision nodes



Link and Node Analysis

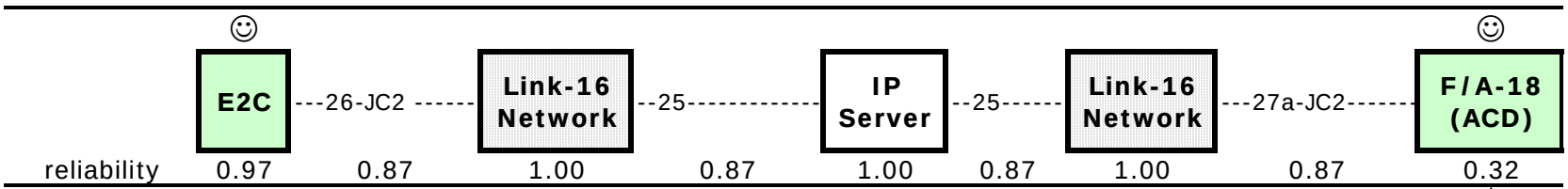
Each path is a series of decision nodes and their communications links



E2C to F/A-18 Information Flow

Info must get to the E2C, be relayed to the F/A-18, and be recognized and interpreted by the crew.

The probability that the Info gets to the last node along this path is the product of the probability that it gets across each link and node in the path.



Probability that E2C crew will successfully transmit info

Probability that information will be transferred through this link

Probability that hardware will perform its tasks correctly and pass the information to the F/A-18

Probability that crew will be able to interpret the info in time to act on it

Multiple Communications paths

AOC Communications Paths to F/A-18

	node	link	node	link	node	link	node	link	node	Probability comms get to F/A-18 along this path
Path 21	AOC	---28 -UHF LOS Voice----------							F/A-18 (voice)	0.75
reliability	0.86722				0.87				0.99	
Path 22	AOC	---20-JC2----------			IP Server	--25-----	Link-16 Network	---27a-JC2-----	F/A-18 (ACD)	0.18
reliability	0.87616		0.87		1.00	0.87	1.00	0.87	0.32	
Path 23	AOC	---20-JC2----------			IP Server	--25-----	Link-16 Network	---27a-JC2-----	F/A-18 (TCD)	0.49
reliability	0.87616		0.87		1.00	0.87	1.00	0.87	0.85	
Path 24	AOC	---20-M2M----------			IP Server	--25-----	Link-16 Network	---27b-M2M----	F/A-18 (M2M)	0.55
reliability	0.87616		0.87		1.00	0.87	1.00	0.87	0.96	
Path 25	AOC	---24-L-16 voice----------					Link-16 Network	---27c-voice---	F/A-18 (voice)	0.66
reliability	0.87616		0.87				1.00	0.87	0.99	

E2C Communications Paths to F/A-18

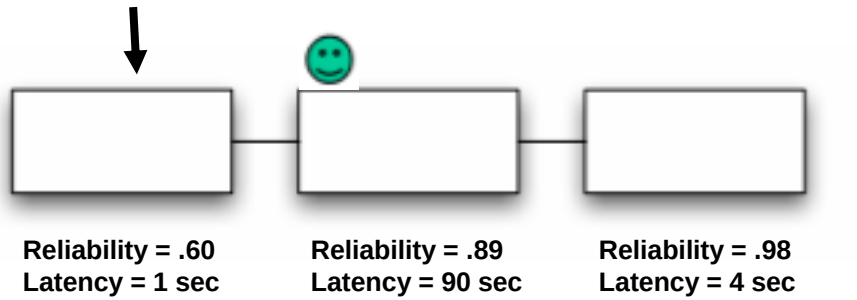
	node	link	node	link	node	link	node	link	node	Probability comms get to F/A-18 along this path
Path 26	E2C	---30-UHF LOS Voice----------							F/A-18 (voice)	0.83
reliability	0.91314				0.92				0.99	
Path 27	E2C	---26-JC2 ----	Link-16 Network	--25----------	IP Server	--25-----	Link-16 Network	---27a-JC2-----	F/A-18 (ACD)	0.18
reliability	0.97324	0.87	1.00	0.87	1.00	0.87	1.00	0.87	0.32	
Path 28	E2C	---26-JC2 ----	Link-16 Network	--25----------	IP Server	--25-----	Link-16 Network	---27a-JC2-----	F/A-18 (TCD)	0.47
reliability	0.97324	0.87	1.00	0.87	1.00	0.87	1.00	0.87	0.85	
Path 29	E2C	---26-M2M----	Link-16 Network	--25----------	IP Server	--25-----	Link-16 Network	---27b-M2M----	F/A-18 (M2M)	0.47
reliability	0.86288	0.87	1.00	0.87	1.00	0.87	1.00	0.87	0.96	
Path 30	E2C	---26-Voice----	Link-16 Network	---27c-Voice----------					F/A-18 (voice)	0.68
reliability	0.91314	0.87	1.00	0.87					0.99	

CSEL and MMC voice Paths to F/A-18

	node	link	node	link	node	link	node	link	node	Probability comms get to F/A-18 along this path
Path 31	CSEL	---1-UHF LOS Voice ----------							F/A-18 (radio)	0.89
reliability	0.9801				0.92				0.99	
Path 32	MMC	---13-Voice----------			UHF Satcom	---22-Voice ----------			F/A-18 (radio)	0.00
reliability	0.96		0.89		0.98		0.00		0.99	

Human performance problems can be isolated

System reliability = 0.60 x 0.89 x 0.98 = 52% (an equipment problem)

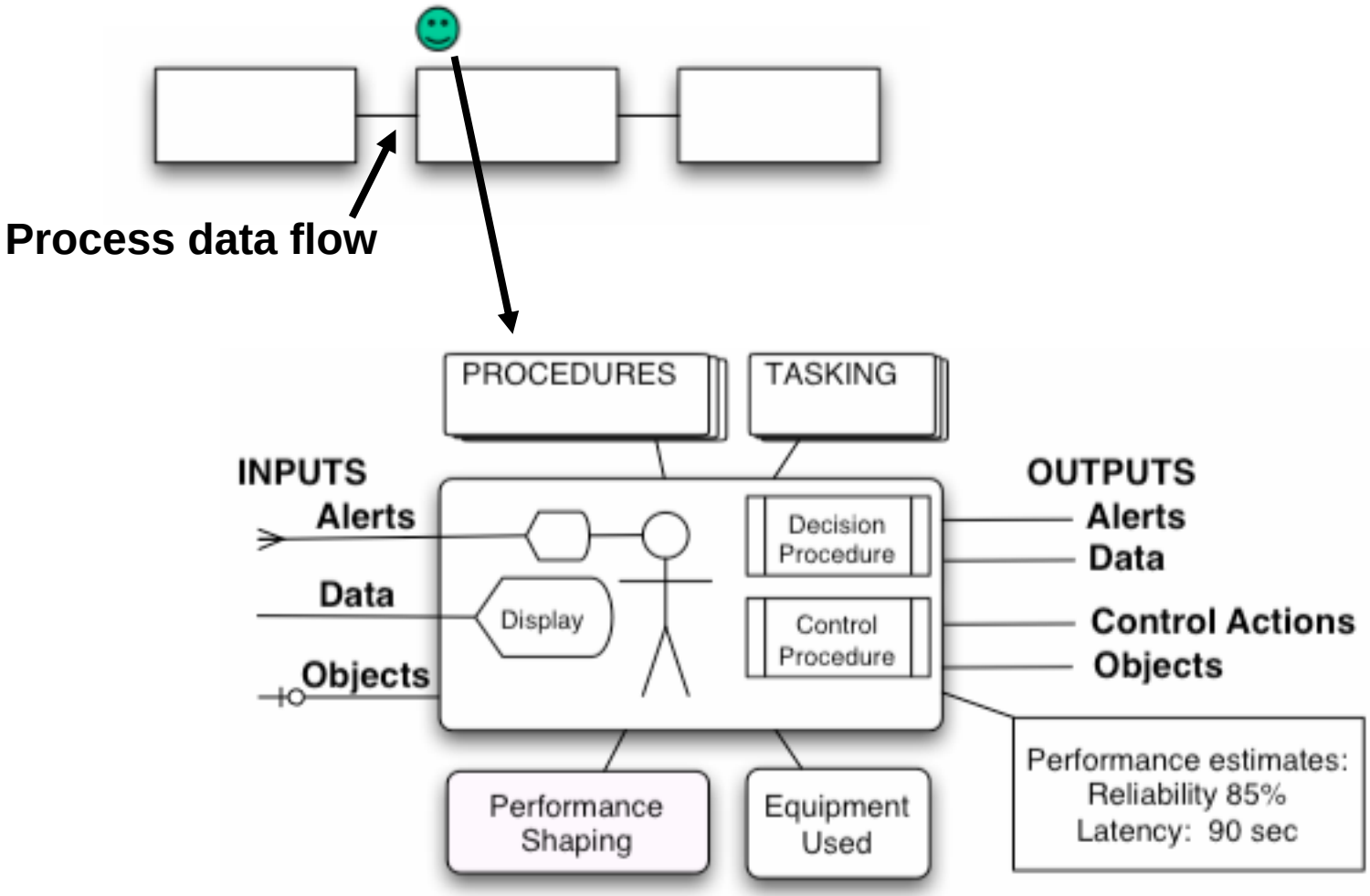


System Latency = 1 + 90 + 4 = 95 seconds (a human performance problem)

Result: The analyst can isolate effects of equipment and HSI performance on the system

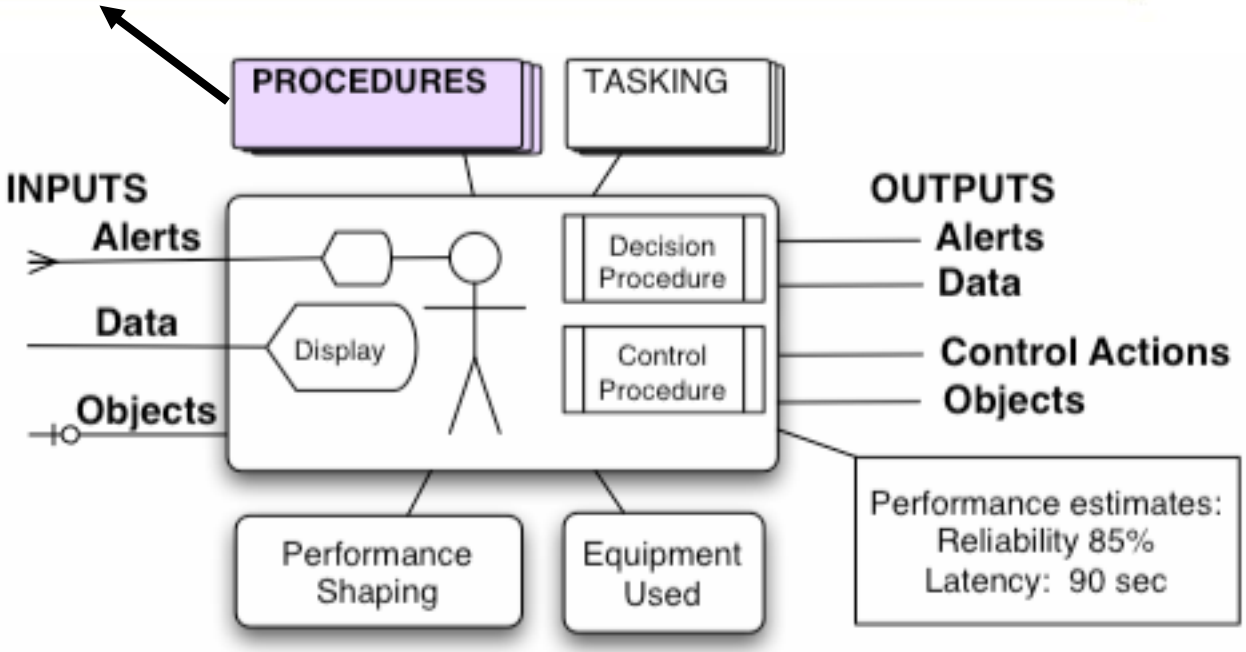
Human Performance within a node can be modeled

“Smiley face” flags human performance within a node



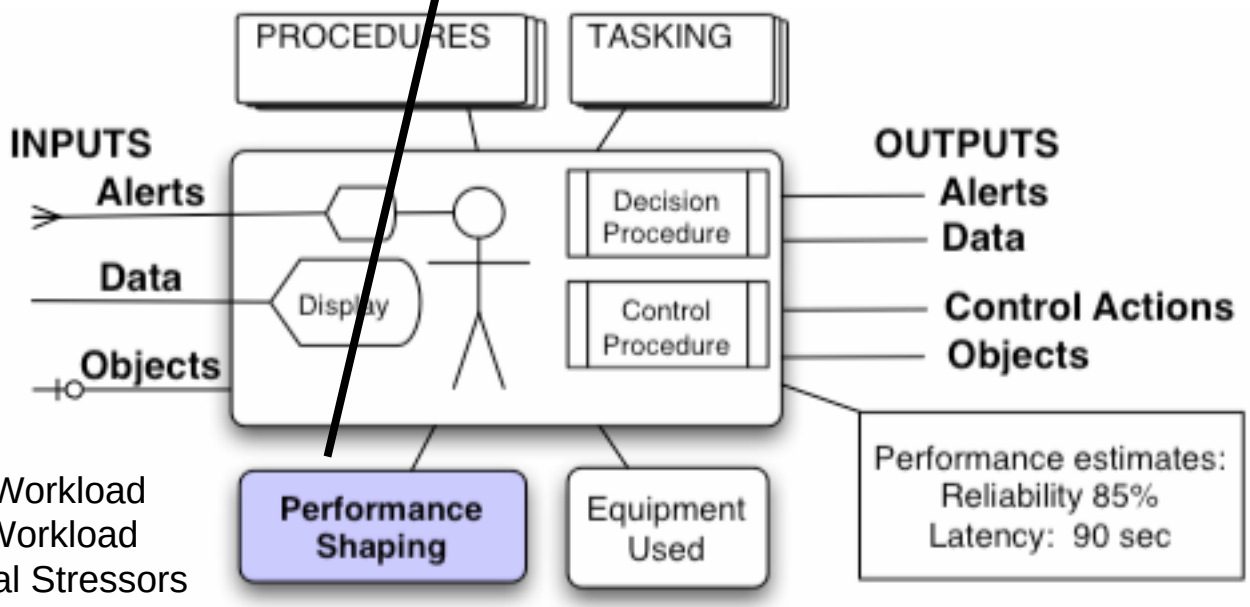
"Procedures" describe tasks that the humans perform

	Info used	Equipment	Latency Equation	Performance Equation	Output
Procedure A	A, B	COTP, Radio	20 Sec + Trigger Detection + RFI (info B)	Trigger Detection .75 Late = 10% Wrong Decision = 5% f(fatigue, training, skills)	Alert sent to AOC
Procedure B					



"Performance shaping" modifies human performance

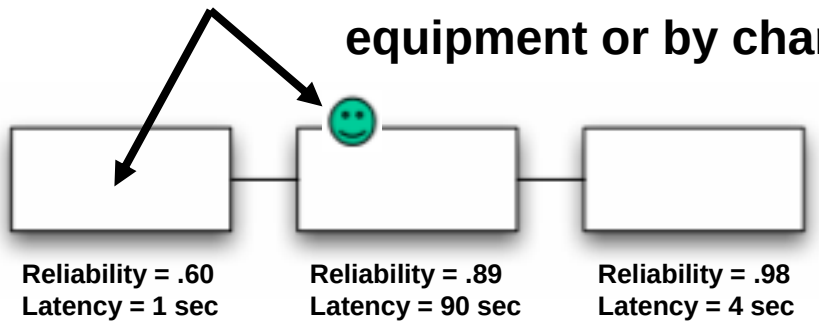
Reliability = .85
Latency = 90 seconds



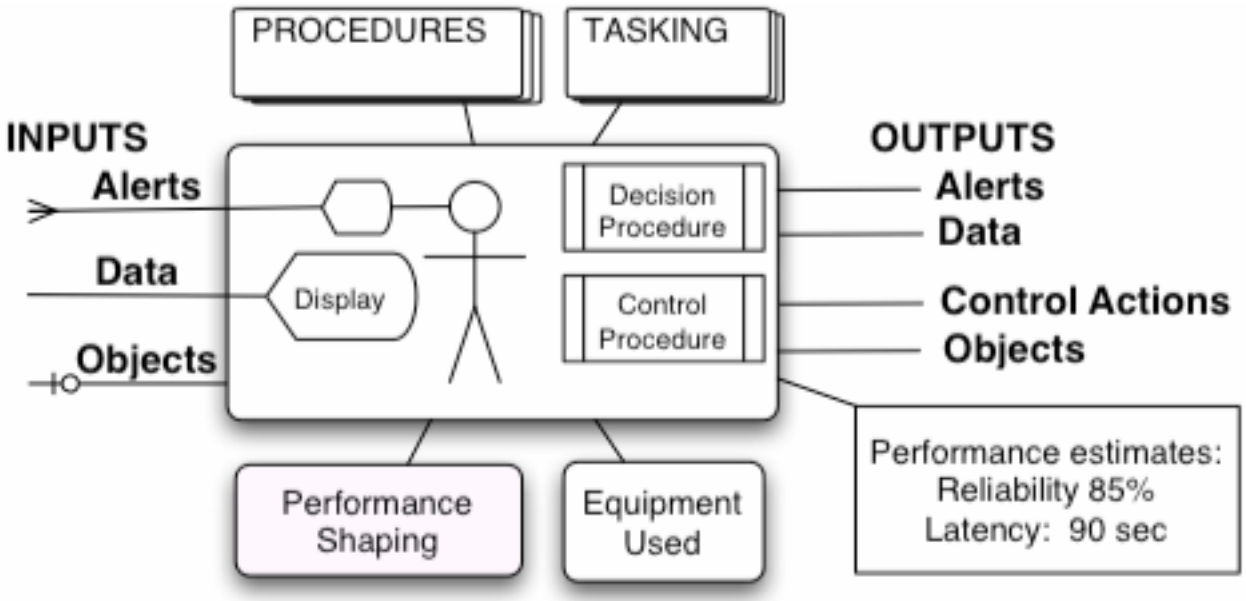
Cognitive Workload
Physical Workload
Environmental Stressors
Training
Skills
Experience

Compare Performance Shaping alternatives

Performance can be improved by modifying the equipment or by changing human performance



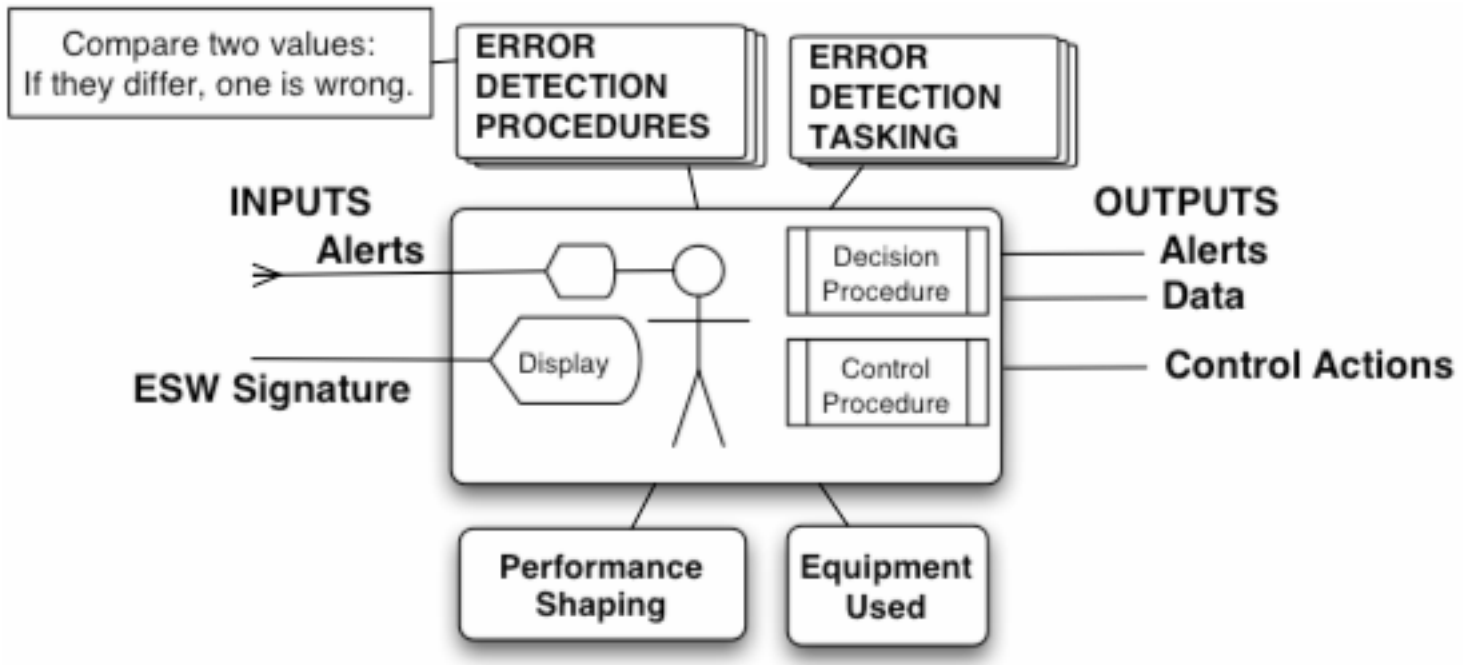
HSI Support added to shape human performance



Error Detection

Error detection can be improved by bringing extra information and detection procedures to a node.

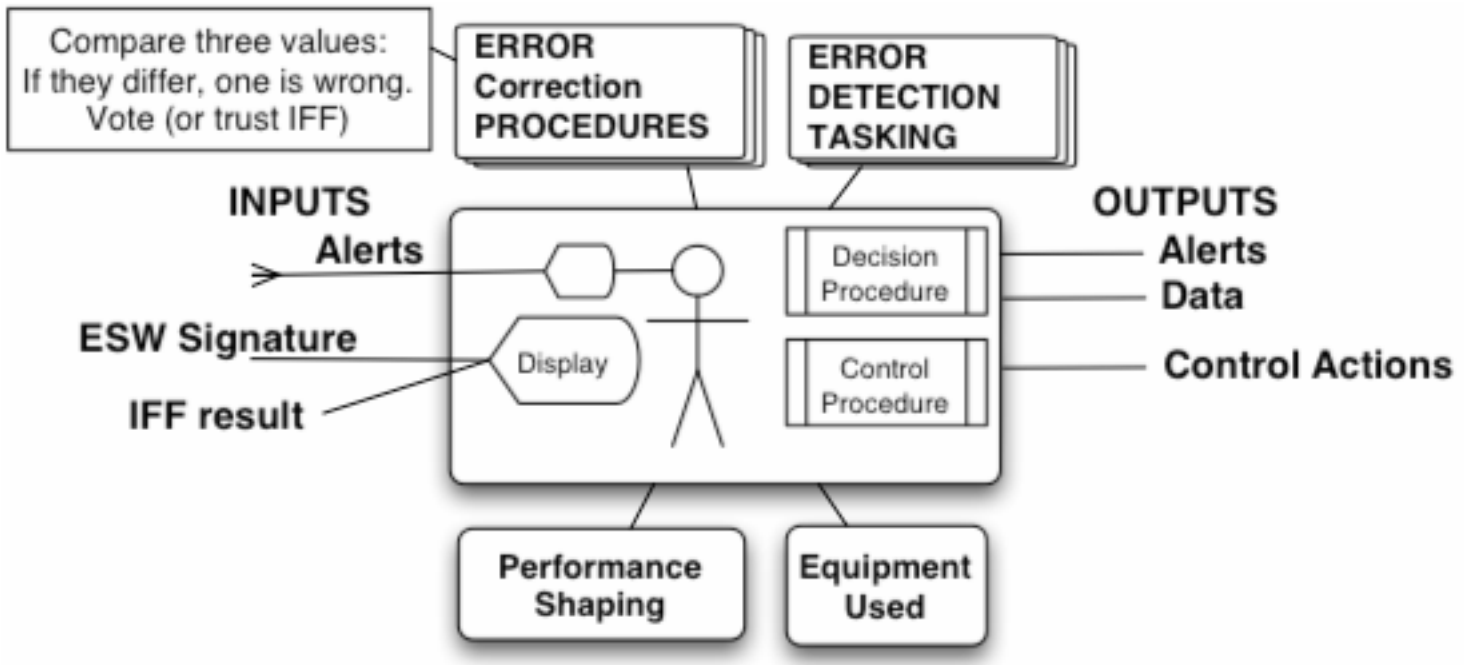
Example: Platform ID



Error Correction

Even more information (and training) is required to correct errors

Example: Platform ID



Summary

1. Use NCDP Use Case diagrams to identify decision nodes and communications links.
2. Calculate reliability, latency, and potential errors for equipment and human tasks in each link and node.
3. Identify potential HSI problems and use performance shaping to resolve them.

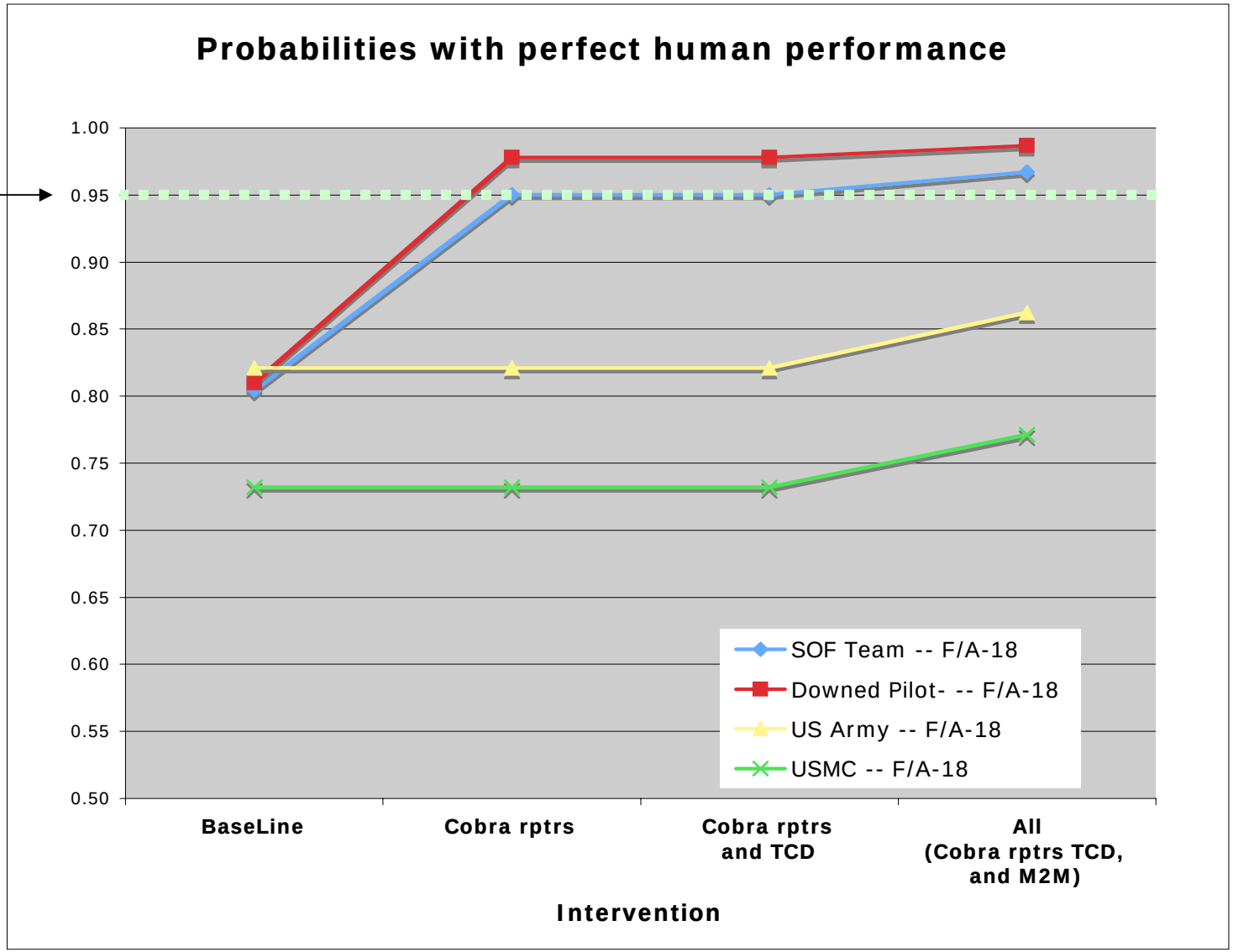
RESULTS

BFSA Study: Judy Byram SPAWAR 051

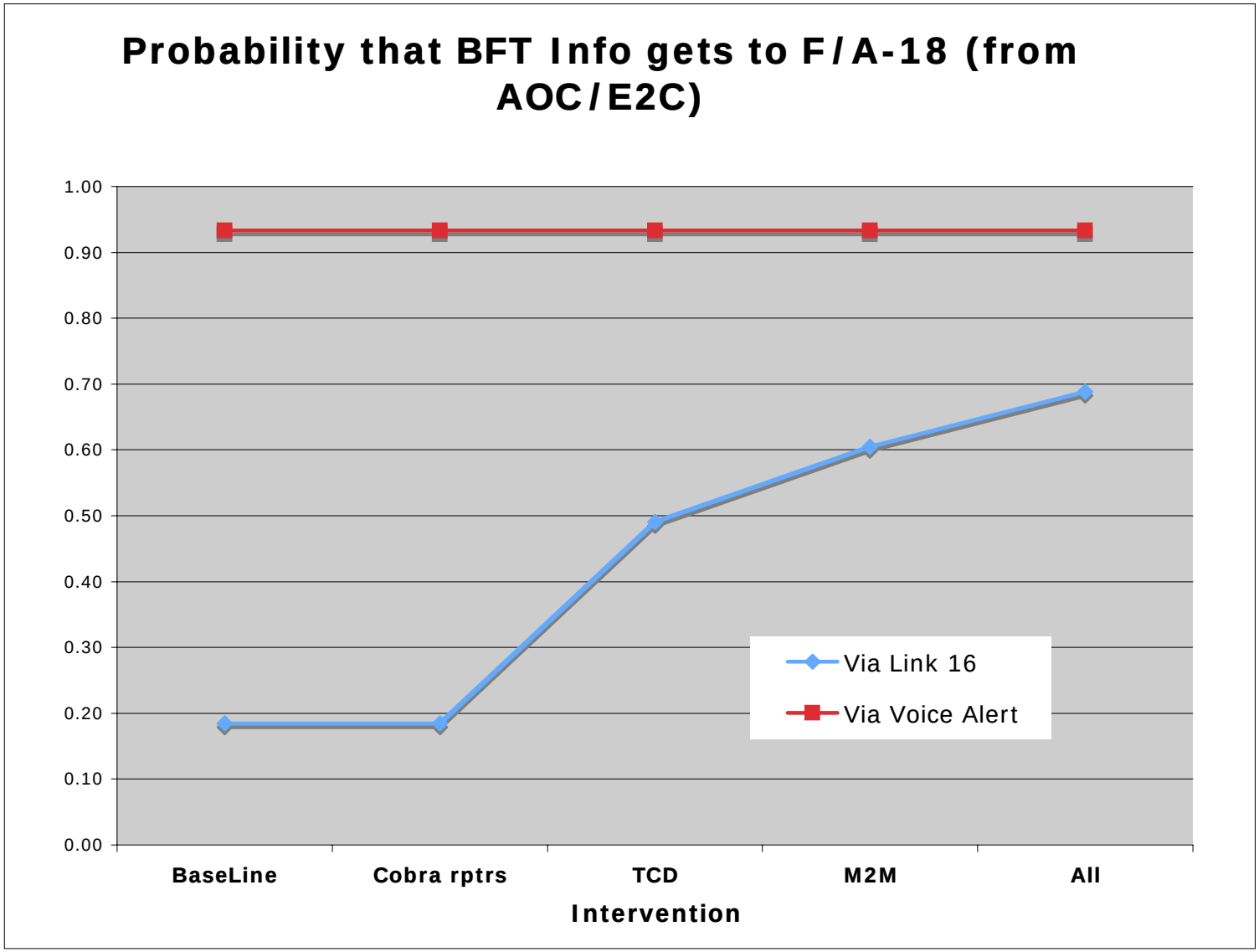
- Link & Node approach used to identify human performance problems in the F/A-18 decision node:
  - Time available for the crew to de-conflict the target area was too short.
- Suggested attention-focusing aids to reduce the crew's workload.
- Evaluated hardware solutions designed to increase the de-confliction window.

IDENTIFYING BLUE UNITS (Assuming perfect human performance)

Combat ID material standard for friendly ID systems



Human Performance CONSIDERED



Future Directions

- Link and Node process models are being developed
- SSC-Charleston is adding human performance modeling to their Gemini toolset
  - Human performance within a decision node can be modeled
  - Effect of performance shaping on outcomes will be evaluated

That's all Folks!

QUESTIONS?

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